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PROGRESS REPORT

REFINEMENT AND PRODUCTION OF 1000 RUGGED X-BAND LOCAL OSCILLATOR V-52 KLYSTRONS

For Period: 1 September to 30 September 1952

Prepared for

Bureau of Ships Navy Department

on

BuShips Contract NObs-5358

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PURPOSE

The purpose of the program engaged under BuShips Contract NObs-5358 is to refine and produce one thousand (1000) rugged X-band local oscillator V-52 klystrons. This tube is to comply with the specifications of SHIPS E-720, which were subsequently modified at a conference held at the Bureau of Ordnance, Washington, D.C., on May 20-21, 1952 and later at a conference held at Varian Associates on September 29-30, 1952.

PROGRESS

Tube Design Changes

Concerning the problem of temperature compensation,[1] there is a possibility that the reflector header or grid structure may be bowing as the tube heats up. Tubes will be constructed that have a slightly different header to determine if this improves performance. Also, it appears that the drift tube may be lengthened slightly without altering the resonator appreciably. This will also be tried in a few tubes.

In regard to residual frequenoy-modulation, some of the tubes which have been tested exhibited ion oscillation. This sometimes causes a low frequency beam fluctuation resulting in FM noise. The ion oscillation occurs in the drift tube. Ion oscillation noise is a problem that is common to many reflex klystrons, and although the phenomena is not completely understood, some remedies are known. One of these consists of making a hole in the center of the smoother grid, which allows some of the ions to be drained out of the drift tube. This appears to reduce greatly the ion oscillation in the drift tube. This remedy has been tried on a few V-52 tubes and seems to be satisfactory. Future tubes will in all probability incorporate this change.

Two tubes were constructed with a modified refleotor. The new reflector has a larger diameter and a turned-up edge slightly longer than the previous design. One of the tubes had excessive beam current and, in

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1 Varian Engineering Report No. 132-2

general, its performance was below average. The other tube had greater than average power output, but electronic tuning was slightly below average. Both tubes, however, had more nearly symmetrical mode shapes and only slight hysteresis. More tubes will be constructed in this manner and tested to determine whether or not this change should be incorporated in all future tubes.

As the design of the tube now stands, it is necessary to adjust the output iris screw in order to match the tube to the load as the frequency is varied. Unfortunately, the coupling characteristic of the tube is not a simple monotonic curve as is ordinarily the case. Consequently, a simple fixed coupling device that will properly match the tube to the load over the tuning range is not simply designed. Considerable work is being done on this problem, but so far a simple solution has not been found.

Another problem is the presence of unwanted modes of oscillation. This problem has been partially solved by the mode suppressing screws, but these too often require some adjustment as the tube is tuned. An ideal solution would be an output coupling device that loaded the unwanted modes out of oscillation. Such a solution is being investigated in conjunction with the matching problem.

A conference was held between representatives of Consolidated Vultee; Bendix; Capehart-Farnsworth; Inspector of Naval Material, San Francisco; BuOrd Re9b; Applied Physics Laboratory, Johns Hopkins University; and Varian Associates on September 29-30, 1952. It was shown that the V-52 tube now meets all of the specifications for the 1000-tube contract (BuShips Contract NObs-5358) with the exception of warm-up time. The test yield for all of the specification items on the basis of past experience has been only about 50 per cent because of difficulties in meeting the electronic tuning range requirement. The problem of warm-up time was discussed, and it was pointed out that the tubes have changed their characteristics such that the warm-up time is now approximately 1/3 to 1/2 hour. It was agreed that every attempt to improve the warm-up time of the V-52 would be made in order to meet the specification.

The following specification changes were agreed upon in the V-52 contract for 1000-tubes (BuShips Contract NObs-5358):

1. Beam current, oscillating, shall be less than 60 ma at 350 volts. This should result in a beam current which is less than 50 ma at 300 volts.

2. Modulation or reflector sensitivity shall be greater than 1 mc/v for both power output test conditions. Convair desired a maximum limit, and they would like to have information as to how uniform modulation sensitivity can be made.

3. There shall be no discontinuities between the half-power output points of the reflector voltage mode.

4. Residual FM shall be less than 0.1 mc with an a-c filament voltage.

5. Warm-up time was redefined as follows: After the application of all voltages for a warm-up time of 20 seconds, the frequency shall be recorded.

For the next 10 minutes, the frequency shall remain within 3 mc of this value. Data are to be taken for the next hour of operation, and the largest frequency change observed during that hour recorded. This test must be made with no blower, at room temperature, and with the tube thermally insulated from the measuring equipment with a thin plastic or mica insulator.

6. Life tests shall be made as discussed under the 50-tube contract (BuShips Contract NObrs-52503). It is hoped that the tubes will also meet a 500-hour intermittent life test.

7. The vibration particle test will remain unspecified. It was proposed that this test be a simple vibration test, probably at 60 cycles, possibly at 15 G, in which the reflector and cathode currents are measured. Limits would be established for allowable changes in reflector and cathode currents when sufficient information becomes available as to both system requirements and tube performance.

8. Mechanical tuning rate shall be less than 400 mc per turn of the tuner shaft.

The complete up-to-date specifications for BuShips Contract NObs-5358 are shown in Table I.

TABLE I

V-52 SPECIFICATIONS FOR BUSHIPS CONTRACT NObs-5358
Agreed upon September 29, 1952

SPECIFICATION REQUIREMENTS	UNITS	TEST LIMITS "Convair"	"Federal"
E_f	v	6.3 ± 10%	
I_f at 6.3 volts	a	1.2 ± 10%	
Maximum Resonator Voltage	v-dc	300	350
Maximum Reflector Voltage	v-dc	175	300
Maximum Resonator Current, oscillating	ma	50	60
Maximum Reflector Current	μa	5	5
Mechanical Tuning Range	mc	8800 - 9600	
Minimum Power Output (VSWR less than 1.2) (at peak of mode)	mw	25	100
Minimum Electronic Tuning Range between 1/2 power points - no discontinuities in this range	mc	40	30
Warm-up Time - to within 3 mc of frequency after 10 minutes (record frequency for next hour)(All voltages applied at start of test)	sec	20	20
Temperature Stability (Stabilize at -10°C; raise to 85°C for 2 minutes)	mc	6	6
Minimum Repeller or Modulation Sensitivity	mc/v	1	1
Shock Stability - 250 G - 40 ms	mc	2	2
Altitude Stability - 1 to 0.1 at.	mc	1	1
Surface Leakage (Refl.) - 95% Hum.	meg-Ω	100	100
Vibration Frequency Stability - 5 G 10 to 1000 cycles	mc-P-P	0.2	0.2

TABLE I (Cont'd)

SPECIFICATION REQUIREMENTS	UNITS	TEST LIMITS "Convair"	"Federal"
Output Coupling (Sealed)		UG39/U	
Minimum Life @ 150°F, continuous	hr	---	500
Maximum dimensions - in cavity	in.	3 x 2-1/2 x 2-1/2	
Lead Length	in.	18	18
Vibration Particle Test (15 G, 40 cps)		TBS	TBS
Residual FM with AC Filament Voltage	mc	0.1	0.1
Maximum Mechanical Tuning Rate	mc/turn	400	400

Manufacturing Changes

No manufacturing changes were made during the month of September.

Production Accomplishments

The techniques of V-52 manufacture adaptable to large-scale production continued to be studied, with emphasis on the problem of brazing the cathode in a fast, inexpensive, efficient manner. The V-52 employs a cathode which has been brazed by a titanium-hydride technique. This ceramic brazing method is done in a vacuum and is slow, laborious, and expensive.

Another ceramic brazing technique is moly-manganese brazing in a high temperature hydrogen furnace. This method avoids brazing in a vacuum, but has not proved too successful thus far.

A menner of brazing to moly has been by the cuprous chloride technique. This method has been used in the laboratory construction of the V-52, which employs a moly drift tube. It is strictly a laboratory process, requiring hand-painting. In addition, the firing causes hydrochloric acid to contaminate the furnace against use for other purposes.

A new method of brazing under study uses an immersion nickel process to prepare for brazing. This technique may be employed any time that brazing to moly is required, including brazing ceramic to moly. Further investigations of this brazing method will be made.

PROGRAM FOR NEXT INTERVAL

Tubes with a longer drift tube will be built to determine if this improves warm-up performance. In addition, more tubes with a modified reflector will be made.

The technique of immersing moly in a nickel solution before brazing will be studied as a manufacturing method applicable to large-scale production.

Tooling for the assembly of the first V-52 tubes on this contract will be completed during the next month.

Actual expenditures during September 1952:	$13,981.00
Actual man-hours during September 1952:	1618